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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte ADAM R. PAWLOSKI, AMR Y. ABDO,
GILLES R. AMBLARD, BRUNO M. LAFONTAINE,
IVAN LALOVIC, HARRY J. LEVINSON,
JEFFREY A. SCHEFSKE, CYRUS E. TABERY,
and FRANK TSAI

Appeal 2009-000205
Application 10/790,457
Technology Center 1700

Decided: February 3, 2010

Before ALLEN R. MACDONALD, *Vice Chief Administrative Patent Judge*, PETER F. KRATZ, and MARK NAGUMO, *Administrative Patent Judges*.

KRATZ, *Administrative Patent Judge*.

DECISION ON APPEAL

This is a decision on an appeal under 35 U.S.C. § 134 from the Examiner's final rejection of claims 1-6, 8-13, 15-21, and 23. We have jurisdiction pursuant to 35 U.S.C. § 6.

Appellants' claimed invention is directed to a method of removing an immersion lithography medium from the surfaces of semiconductor wafers as part of an immersion lithography process. As explained by Appellants, "[i]n immersion lithography, an immersion lithography medium is placed between the final lens of the imaging system and a photosensitive material (e.g., a photoresist) on the surface of a nascent semiconductor device" (Spec. 2: 2-5). Appellants note that "the immersion lithography medium needs to be removed from the semiconductor wafer with which it has been used" in a non-deleterious manner to avoid contamination of subsequent processing steps and the semiconductor device itself (Spec. 2: 18-23). As one embodiment, Appellants note that "polyfluoroethers can be used as the immersion lithography medium in conjunction with a 157 nm light source 14" (Spec. 6: 4-5) and that supercritical carbon dioxide can be used to remove the immersion lithography medium from the wafer surfaces (Spec. 3: 5-12). The separated immersion lithography medium and carbon dioxide can be recovered and reused (Spec. 3: 13-29).

Claim 1 is illustrative and reproduced below:

1. A process for fabricating a semiconductor device, comprising:

applying an immersion lithography medium to a surface of a semiconductor wafer;

exposing a material on the surface of the semiconductor wafer to electromagnetic radiation having a selected wavelength;

applying supercritical carbon dioxide to the semiconductor wafer to remove the immersion lithography medium from the surface of the semiconductor wafer; and

following the step of applying supercritical carbon dioxide to the

wafer, obtaining a mixture of the immersion lithography medium removed from the surface and carbon dioxide and recovering and purifying the immersion lithography medium from the mixture.

The Examiner relies on the following prior art references as evidence in rejecting the appealed claims:

Wallace	6,024,801	Feb. 15, 2000
Costantini	US 6,612,317 B2	Sep. 2, 2003

Switkes, "Immersion Lithography at 157nm" J. Vac. Sci. Technol. B. 19(6), Nov./Dec. 2001, pp. 2353-2356

The Examiner maintains the following ground of rejection:

Claims 1-6, 8-13, 15-21, and 23 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Switkes in view of Wallace and Costantini.

We reverse the stated rejection. Our reasoning follows.

All of the appealed claims require a process including at least the following steps: (1) applying immersion lithography medium to a semiconductor surface; (2) exposing material on the wafer surface to a selected wavelength of electromagnetic radiation; (3) applying supercritical carbon dioxide to the wafer to remove the immersion lithography medium from the wafer surface; and (4) obtaining a mixture of removed immersion lithography medium and carbon dioxide following step (3) and recovering and purifying immersion lithography medium from the admixture (claims 1, 10, and 16).

The Examiner relies on Switkes for teaching steps corresponding to the first two steps of Appellants' claimed process, as noted above (Ans. 4; Switkes, pp. 2353-2355). The Examiner acknowledges that Switkes, the

primary reference, does not disclose the use of supercritical carbon dioxide to remove immersion lithography medium, such as the perflouropolyether of Switkes, from a semiconductor wafer, as Appellants' process requires (Ans. 4 and 5). Consequently, Switkes fails to disclose the subsequent steps of obtaining a mixture of carbon dioxide and removed immersion lithography fluid, and recovering and purifying the medium from the admixture, as Appellants' process requires (Ans. 5).

However, based on additional alleged teachings attributed to Wallace and Costantini, the Examiner takes the position that:

> [i]t would have been obvious to one of ordinary skill in the art at the time of invention by applicant to modify the teachings of Switkes et al in view of Wallace ('801) and further in view of Costantini ('317), in order to recover the immersion lithography medium that is removed by applying supercritical CO_2 to the wafer, because Wallace ('801) teaches that supercritical fluids such as supercritical CO_2 can be use[d] to remove substances such [as] fluorocarbons from the surface [of] a semiconductor wafer, and Costantini ('317) teaches that one can recover and then purify effluent from a semiconductor wafer processing chamber in order to recycle the immersion lithography medium that is recovered back to the semiconductor wafer processing chamber for re-use, resulting in a more economically efficient semiconductor wafer processing method.

Ans. 6-7

Appellants contrarily urge that while Wallace teaches the use of fluids, such as carbon dioxide, in a supercritical state, for removal of substances from a semiconductor wafer prior to a passivation treatment, Wallace has nothing to do with immersion lithography (App. Br. 7). Appellants contend that Wallace's disclosure of fluorocarbon, as referred to by the Examiner has little to do with their claimed process and that the

teachings of Costantini, as relied upon by the Examiner, are not directed to an immersion lithography process wherein the immersion medium is recovered and purified after using carbon dioxide for extraction thereof from a wafer (App. Br. 7-8). Rather, Appellants urge that Costantini is directed to the recovery and reuse of a co-solvent and solvent (carbon dioxide) used as part of the cleaning medium, a part of a super critical fluid, used in a wafer cleaning process. *Id.*

Consequently, Appellants argue, in essence, that the Examiner has read too much into the applied references and has failed to discharge the burden of establishing an adequate factual basis and provide a rationale reason that supports the Examiner's proposed modification of Switkes's immersion lithography process such that it would have been reasonable to expect that an ordinarily skilled artisan would have arrived at Appellants' claimed process with a reasonable expectation of success based on the applied teachings of the combined references (App. Br. 7-15; see generally Reply Br.).

DISPOSITIVE ISSUE

Have Appellants shown error in the Examiner's obviousness determination because the Examiner has not supplied an adequate factual basis and reasoning to establish, prima facie, that one of ordinary skill in the art would have been led to modify the immersion lithography process of Switkes so as to arrive at a process corresponding to the claimed process with a reasonable expectation of success in so doing, by including a step of applying supercritical carbon dioxide to remove the immersion medium of Switkes from a semiconductor wafer and steps of subsequently recovering

and purifying the immersion medium from an admixture with carbon dioxide based on the combined teachings of Switkes, Wallace and Costantini, as applied by the Examiner?

PRINCIPLES OF LAW

The Examiner bears the initial burden, on review of prior art or on any other ground, of presenting a prima facie case of unpatentability. *In re Oetiker*, 977 F.2d 1443, 1445 (Fed. Cir. 1992). However, on appeal to this Board, Appellants must present argument to show that the Examiner erred in rejecting the claims. *See* 37 C.F.R. § 41.37(c)(1)(vii).

"[R]ejections on obviousness grounds cannot be sustained by mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness." *KSR Int'l v. Teleflex, Inc.*, 550 U.S. 398, 418 (2007) (quoting *In re Kahn,* 441 F.3d 977, 988 (Fed. Cir. 2006)). In this regard, "a patent composed of several elements is not proved obvious merely by demonstrating that each of its elements was, independently, known in the prior art." *Id.*

Rejections based on § 103(a) must rest on a factual basis with these facts being interpreted without hindsight reconstruction of the invention from the prior art. *See In re Warner*, 379 F.2d 1011, 1017 (CCPA 1967), *cert. denied*, 389 U.S. 1057 (1968).

FINDINGS OF FACT

In addition to findings of fact set forth elsewhere in this Opinion, we determine the following relevant findings of fact by a preponderance of the evidence standard.

Switkes discloses and/or suggests a method of forming a semiconductor device wherein: (1) a non-toxic, chemically inert, clean room environment compatible immersion lithography medium, such as perfluoropolyether (PFPE, commercially available as Fomblin®Y or Z) , is applied to a semiconductor wafer surface; (2) the wafer surface is exposed to electromagnetic radiation of a specified wavelength, such as at a wavelength of 157 nm, and (3) the lithography medium is separated from the wafer with a low molecular weight PFPE solvent (Fomblin PFS-1) (pp. 2353-2355; *see* Ans. 4).

Wallace discloses and/or suggests that it is well known to employ a method of processing semiconductor wafers or micromechanical devices of the semiconductor-type wherein the wafers are treated with a supercritical fluid (SCF), such as carbon dioxide, to clean the wafers, such as by removing various liquids (ambient), contaminants, and/or organic compounds therefrom via SCF treatment (col. 3, l. 21- col. 4, l. 37). Wallace further teaches or suggests that SCF can be used to remove soluble chemical compounds prior to passivation treatment to preserve the surface integrity of a part. Finally, Wallace teaches that PFPE can be used for the passivation treatment that follows the SCF treatment (col. 4, l. 65- col. 5, l. 5 and col. 9, ll. 23-27).

While Wallace discloses that "fluorocarbon removal would be facilitated by exposure to UV light in the course of the CO_2 SCF process,"

the Examiner has not pointed out where Wallace explicitly discloses that perfluoropolyether or any specified immersion lithography fluid is dissolvable and removed from a wafer by SCF treatment with carbon dioxide (Wallace, col. 8, ll. 55-57; *see generally* the Examiner's Answer).

Costantini teaches or suggests a fluid delivery and recovery system for use in supercritical fluid (SCF) treatment of semi-conductor wafers wherein, after the wafer cleaning, the effluent materials separated from the wafer can be processed by separation for recovery, purification, recycle, and/or disposal of the various materials found in the effluent obtained from the supercritical fluid treatment of the wafer (*see generally* Costantini). Costantini refers to the SCF fluid as "solvent" (col. 5, ll. 7-14).

While Costantini discloses recovery and purification of the SCF solvent (carbon dioxide) and an optional SCF co-solvent after treating a wafer therewith in the disclosure of Costantini relied upon by the Examiner, the Examiner has not shown where Costantini teaches that a material useful as a lithography immersion medium, such as the PFPE of Switkes, is removed from a wafer by a carbon dioxide-containing SCF fluid followed by recovery and purification of such a lithography immersion medium from an admixture with carbon dioxide (Costantini, col. 2, ll. 7-11, col. 3, ll. 24-32, col. 4, ll. 1-10, and col. 6, ll. 6-56; Ans., 5, 6, and 8-12).

ANALYSIS

In formulating the stated rejection, the Examiner asserts that Wallace discloses removal of soluble chemicals and/or a fluorocarbon, from a wafer using SCF carbon dioxide (Ans. 5). However, the Examiner does not reference evidence that substantiates a reasonable expectation of success in

the proposed modification of Switkes' process based on this disclosure of Wallace. In this regard, the Examiner does not adequately explain why the referenced disclosure of Wallace would have taught or suggested, to one of ordinary skill in the art, that an immersion lithography medium corresponding to the perfluoropolyether (PFPE) of Switkes, which is chemically distinct from fluorocarbon, as referenced by the Examiner and addressed by Wallace, would have been removed by SCF carbon dioxide from the immersion lithography treated wafer of Switkes. For example, the Examiner has not cited prior art evidence to establish that PFPE is soluble in SCF carbon dioxide so as to be reasonably expected to be subject to removal from a wafer followed by recovery. Nor has the Examiner otherwise articulated why any other immersion lithography medium, that may have been suggested as being useable in Switkes, would have been reasonably expected to be subject to removal from a wafer by SCF carbon dioxide based on the added teachings of Wallace.

We decline, in the first instance, to explore the record, make express and detailed findings of fact as to the teachings of the references, weight those various findings, and decide, on that basis, whether the Examiner's conclusions are well-founded.

In this appeal, the Examiner's rejection falls short of furnishing a persuasive rationale for the proposed modification of Switkes' immersion lithography process based on the use of SCF carbon dioxide by Wallace for cleaning wafers or devices of materials that have not been shown to be immersion lithography mediums prior to the passivation treatment of Wallace.

Moreover, the Examiner's additional reliance on Costantini does not remedy the aforementioned deficiency in the stated rejection because the Examiner has not identified where Costantini, or any other prior art relied upon in the rejection, teaches that a material useful as an immersion lithography medium in accordance with the process of Switkes, such as PFPE, would be subject to such a removal protocol. In this regard, we again note, for example, that the Examiner does not furnish evidence to establish that PFPE lithography medium would have been expected to be solvated by SCF carbon dioxide.

Also, we note that the Examiner confounds the obviousness position presented in the Answer by overstating and/or mischaracterizing the teachings of the applied references in several locations and then backtracking to seemingly incomplete and/or inconsistent alternative obviousness positions in other locations.

For example, the Examiner maintains that:

> Wallace ('801) claims a method of processing a wafer comprising the steps of: placing the wafer have [sic] a wafer surface in an enclosed and controlled environment; exposing said wafer surface to a cleaning medium rendered as a supercritical fluid; purging said environment of substance including soluble chemical compound liberated from said wafer surface by said cleaning medium. (See, claim 19). Wallace ('801) also discloses an example in which the supercritical fluid used is carbon dioxide. (See, col.8, 31-42). Wallace ('801) further discloses that removal of a material such as a fluorocarbon from the surface of a wafer could be facilitated by exposure to UV light during the exposure of the wafer to supercritical CO_2. These teachings in Wallace ('801) meet the limitation of claims 1, 10 and 16 where supercritical carbon dioxide is applied to a semiconductor wafer to remove

> immersion lithography medium from the surface of a semiconductor wafer.

Ans. 5

In response to Appellants' argument asserting that "Wallace has nothing to do with immersion lithography" and that "[t]he Examiner's reference to the use of UV to remove a fluorocarbon from the surface is completely irrelevant" (App. Br. 7), the Examiner retreats to an incompletely formulated obviousness position based on several referenced "general" teachings of Wallace that allegedly cure a deficiency in Switkes with respect to the SCF carbon dioxide cleaning of a wafer (Ans. 8). However, as noted above, the Examiner does not specifically cite to evidence to substantiate that the generally referred to SCF carbon dioxide cleaning disclosure of Wallace would have been reasonably expected to be applicable to the removal of the PFPE immersion lithography fluid of Switkes by one of ordinary skill in the art.

Similarly, the Examiner overstates the disclosure of Costantini in asserting that, in Costantini "there is a recovery section (See, col. 3, 24-31) that takes in a solvent, which is a mixture of immersion fluid and supercritical $CO_{2,}$, referred to as effluent, obtained from a semiconductor processing chamber (See, col. 6, 6-18)" (Ans. 5-6). In response to argument by Appellants highlighting this error, the Examiner follows with an acknowledgement that Costantini does not explicitly disclose immersion fluid as part of the effluent stream and resorts to reliance on alleged general teachings of Costantini (Ans. 12). However, the Examiner again falls short in furnishing reasoning establishing a sustainable prima facie case of obviousness for the advocated modifications to the immersion lithography

process of Switkes based on the properly interpreted teachings of Wallace and Costantini.

On this record, we determine that Appellants have the better reasoned position with respect to the obviousness question before us.

CONCLUSION

Appellants have shown that the Examiner's obviousness determination is founded on an inadequate factual basis and reasoning to establish, prima facie, that one of ordinary skill in the art would have been led to modify the immersion lithography process of Switkes by including the application of supercritical carbon dioxide to remove the immersion medium of Switkes from the semiconductor wafer and to include a subsequent recovery and purification of the immersion medium from an admixture with carbon dioxide so as to arrive at a process corresponding to the claimed process, with a reasonable expectation of success in so doing, based on the combined teachings of Switkes, Wallace, and Costantini, as referred to and applied by the Examiner.

ORDER

The Examiner's decision to reject claims 1-6, 8-13, 15-21, and 23 under 35 U.S.C. § 103(a) as being unpatentable over Switkes in view of Wallace and Costantini is reversed.

REVERSED

PL Initial:
sld

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